





National Aeronautics and



Integrating Earth Observations into Invasive Species Management Decisions in Big Bend National Park in Texas

Kait Lemon (Project Lead)

Rebecca De Fazio

Margaret Birks

Chloe A Marini



Background



Buffelgrass stand in Big Bend National Park Image Credit: National Park Service

- Invasive perennial grasses, specifically Buffelgrass **Cenchrus ciliaris**, have disrupted dryland ecosystems within the southwest United States
- Originally introduced for erosion control and foraging, they now **threaten biodiversity** and **increase fire risk** in protected areas such as Big Bend National Park
- **Remote sensing** has historically exposed limitations in the spatial analysis of invasive grasses

The Partner: National Park Service

Community Concerns

- Inefficient fire risk mitigation strategies threaten staff, visitors, and protected areas in the park
- Invasive flora species disturb natural ecosystems, out compete native species, and aid in fire risk
- Locations of **Buffelgrass** hotspots are relatively unknown and compromise management efforts



NATIONAL

Study Area: Big Bend National Park, Brewster County, Texas



Basic Information

- **Big Bend National Park** is found in the southwest part of Texas, sharing a border with Mexico
- 3,243 square kilometers of desert, mountains, and rivers
- Largest protected area of the Chihuahuan Desert in the US

Objectives



Earth Observations





Landsat 8 OLI



Sentinel 2A & B MSI



Image Credits: NASA, Rama

Spectral Imagery

Normalized Difference Vegetation Index (NDVI)

- Landsat 8 OLI for 2013, 2017–2019 & 2023
- Targeted NDVI values at 0.15 to 0.35
- Less than 5% cloud cover

Multi-Source Land Imaging (MuSLI)

- 90% maximum greening increase (OGMx)
- Coupled NDVI & OGMx for Habitat Model 2017–2019
- 2016–2023 data used for Buffelgrass detection map

ArcGIS Pro

• All spectral imagery processed in ArcGIS Pro



Habitat Suitability Model Methodology



Fire Risk Assessment Methodology



Buffelgrass Detection Model Methodology



Geospatial Park Zoning Methodology





Zones were determined by

- Elevation
- Road & Trail Access
- Infrastructure
- Campsites

Geospatial Park Zoning Results



- Zones were created to assist the NPS in invasive grass species management
- These zones will allow a more systematic approach to fire risk mitigation
- Viewing Big Bend National Park by zones rather than the entire 3,243 square kilometers of land will greatly improve efficiency

Habitat Suitability Results



Zone	Habitat Suitability	Habitat
	Statistic	Suitability Rank
1	0.3703	9
2	0.3956	7
3	0.3578	10
4	0.4064	5
5	0.3005	17
6	0.2397	20
7	0.3229	13
8	0.4967	2
9	0.3233	12
10	0.3094	16
11	0.3573	11
12	0.3222	14
13	0.2695	19
14	0.3166	15
15	0.4800	3
16	0.3961	6
17	0.4317	4
18	0.3869	8
19	0.5218	1
20	0.2757	18

Fire Risk Assessment Results



Zone	Fire Risk	Fire Risk
	Assessment	Assessment Rank
1	0.2453	18
2	0.3108	12
3	0.2294	19
4	0.3572	7
5	0.2685	16
6	0.2854	13
7	0.3668	6
8	0.6310	2
9	0.2810	14
10	0.6567	1
11	0.3326	8
12	0.2593	17
13	0.3115	11
14	0.2769	15
15	0.3286	9
16	0.3151	10
17	0.3745	4
18	0.3691	5
19	0.4877	3
20	0.2278	20

Buffelgrass Detection Results



Confusion Matrix



Errors, Uncertainties & Limitations

- Co-dominant species and habitable, visible vegetation was cut off at 2% correlation
- Precipitation and temperature data collected through four weather stations at different elevations
- Last known In Situ data for Buffelgrass was collected in 2018
- Time limitations and accessibility to commercial satellite imagery
- Lack of NDVI data for far west corner of the park



Big Bend National Park Image Credit: National Park Service

Future Work

- Using a collaboration of drone collected data as well as ground surveys to confirm analytics and results
- Incorporating multi spectral satellite data to calibrate our model to locate Buffelgrass more preciously
- Applying these models to other invasive perineal grass species to address environmental and safety concerns in the park



Big Bend National Park Image Credit: National Park Service

Conclusion

- **Created** park zones that allowed for a systematic method of analysis for calculating habitat suitability and fire risk
- **Performed** a comprehensive habitat suitability and fire risk assessment which prioritized mitigation and management efforts for Big Bend National Park
- **Combined** multi-source land image phenology data with optimal habitat suitability to generate a species detection map with 81% overall accuracy



Big Bend National Park Image Credit: National Park Service

Acknowledgments

Lead

Cristina Villalobos-Heredia

Science Advisors

- Dr. Jeffrey Luvall, NASA Marshall Space Flight Center
- Dr. Robert Griffin, The University of Alabama, Huntsville

Partners

- Marie Landis, National Park Service
- Carolyn Whiting, Big Bend National Park

Additional Advisors

- Dr. Kent Ross
- Dr. Mark Friedl
- Eric Anderson



This material is based upon work supported by NASA through contract 80LARC23FA024. Any mention of a commercial product, service, or activity in this material does not constitute NASA endorsement. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration and partner organizations.

